Designing Microbial Consortia with Defined Social Interactions

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Project Goals: We developed social interaction engineering as a systematic strategy for the design and construction of synthetic microbial ecosystems.

Designer microbial consortia are communities of rationally designed, interacting microorganisms that are capable of producing desired behaviors. Compared to engineered isogenic populations, synthetic communities offer an increased degree of robustness for designed cellular functions and an expanded spectrum of functional programmability for complex tasks. They have also emerged as a promising engineering tool to manipulate microbiomes, which helps to realize the enormous potential of microbiomes for therapeutic, environmental, and agricultural purposes. However, despite increasing exciting proof-of-concept demonstrations, the utilization of such synthetic ecosystems is hampered by our limited ability in rapidly developing microbial ecosystems with desired temporal and spatial dynamics. Inspired by the facts that social interactions such as competition and cooperation are both ubiquitous and essential in microbial communities. findings, here we present a systematic framework to the design, construction and characterization of synthetic microbial communities, namely, social interaction programming that combines modular pathway reconfiguration with model creation. Specifically, we employed a modular pathway reconfiguration approach to create six distinct consortia whose dynamics is specified by their underlying interaction modes. Using a modular approach similar to our experimental construction, we also derived quantitative models that captured experimentally observed population patterns. We further showed that the models from two-strain consortia can be used to design and build three- and four-strain ecosystems with predictable behaviors. Together, we established social interaction engineering as an effective route for ecosystem programming.

References

1. W. Kong, D. Meldgin, J. Collins, and T. Lu, Designing microbial consortia with defined social interactions, Nature Chemical Biology, 14: 821–829 (2018).